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Jensen, Per Anker; Maslesa, Esmir

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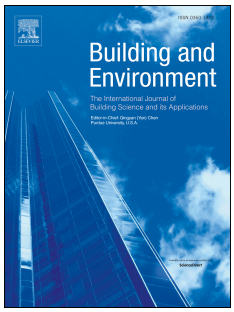

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Per Anker Jensen, Esmir Maslesa

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VALUE BASED BUILDING RENOVATION –

A TOOL FOR DECISION-MAKING AND EVALUATION

Per Anker Jensen and Esmir Maslesa

Centre for Facilities Management

DTU Management Engineering

Technical University of Denmark

Produktionstorvet building 424

2800 Lyngby

Denmark

Corresponding author:

Per Anker Jensen

pank@dtu.dk

+45 45251674

VALUE BASED BUILDING RENOVATION –

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ABSTRACT

Research on the barriers for building renovation in Denmark has revealed that an important obstacle is a lack of simple and holistic tools that can assist stakeholders in prioritisation and decision-making during the early stages of building renovation projects. The purpose of this article is to present a tool - RENO-EVALUE, which can be used as decision support for sustainable renovation projects, and for evaluation, during and after building renovations. The tool is a result from the European Eracobuild project ACES – "A concept for promotion of sustainable retrofitting and renovation in early stages". This article presents the main result of a work package concerning benefits of renovation. RENO-EVALUE has been developed from four case studies on renovation projects in Denmark, tested and validated on the cases and in a Delphi study. The tool is value based by focusing on the different interests and values of the main stakeholders involved in building renovation. It is meant as a basis for dialogue among building professionals and building users and supports formulation of objectives for renovation projects. RENO-EVALUE can also be used for comparing alternative project proposals and to follow-up on a project and assess the results. The tool covers the four main parameters: Stakeholders, Environment, Organisation, and Economy. The evaluations are collected from different stakeholders by use of standardised information and interview templates. The test results of one case study of a social housing estate are presented.

KEYWORDS: decision-making; stakeholders, evaluation; renovation; buildings

1 INTRODUCTION

Renovation of buildings is currently achieving increased attention in many European countries. A fundamental reason for this is an aging building stock following the huge increase in new building activities in the years following the Second World War. Throughout their life time, buildings deteriorate and become less attractive, if not maintained properly. The fact that we spend most of our time indoors indicates, why healthy and well-performing buildings are of a such importance, not only for our global society, but also for the health conditions of every single of us that spend most of our lifetime indoors. Other appealing reasons for building renovations are higher energy prices and the increasing focus on sustainability. There is an emerging need to reduce consumption of fossil energy resources and CO_2-emissions in order to avoid serious climate effects in the future [1]. Still higher demands on energy performance of new buildings in EU-regulations and national buildings codes mean that the discrepancy in energy performance between existing buildings and new buildings becomes greater and greater. Even though the need for renovation of existing buildings is increasing, there are still fairly limited actual renovation activities going on in most countries. There are many different reasons for this, which has been shown in a number of research studies on barriers and incentives, see section 2.3.

This article is based on the joint European research project: ”A concept for promotion of sustainable retrofitting and renovation in early stage” (ACES), in which the Technical University of Denmark, the Royal Institute of Technology, Sweden, and Frederick University, Cyprus were involved. It was based on the fact that approximately more than 40% of the total energy in Europe is spent within the buildings sector, which significantly contributes to greenhouse effects and air pollution. Moreover, it is estimated that approximately 85% of the 160 million buildings within the European Union are thermally inefficient [2]. Hence, it is crucial for the existing building stock to become refurbished.

The ACES project was carried out from September 2011 to November 2013 and was part of the European Eracobuild programme with a particular focus on Value Driven Processes. The Danish part of the research received financial support from the Danish Energy Agency. The agency did not have any role in the research besides acceptance of progress and final reporting and participation with a representative in one round of a Delphi study. The agency has not had any involvement in the decision to submit this article.

The project was divided in a number of work packages and this article concerns WP2 on evaluation of the economic and environmental benefits of sustainable renovation of buildings. It is based on the view that the value of renovation is evaluated differently by different stakeholders, so it is important to highlight the main stakeholder's subjective viewpoints. The purpose of this article is to present the main findings and in particular the resulting tool called RENO-EVALUE. The use of the tool is illustrated by one of the case studies concerning a social housing renovation project during the early stages of design phase. The reason for developing the tool is that research on the barriers for building renovation in Denmark has revealed that an important obstacle is a lack of simple and holistic tools that can assist stakeholders in prioritisation and decision-making during the early stages of building renovation projects [3]. The article is structured with literature review in section 2. The methodology of the empirical study is explained in section 3. The findings are presented in section 4 with outlining RENO-EVALUE followed by a case study. The article is finished with discussion in section 5 and conclusion in section 6.

In the article renovation will be used as a general term for improvements of the performance of existing building. Renovation can be part of planned maintenance and improvement. This can be in the form of rebuilding, refurbishing or retrofitting a building as part of modernization or adaptation

to changing use. It can also be in the form of restoration or preservation of cultural heritage like historic or listed buildings. The main focus is on renovation of buildings, which involves a considerable improvement in their energy performance [4]. Building renovation is defined more specific in section 2.1.

2 LITERATURE REVIEW

2.1 The need for building renovation

40 % of total energy consumption in European Union is used in buildings [5]. Besides that, it is being estimated that people globally spend approximately 70 % of their time in buildings [1], which explains why healthy and well-performing buildings should be of importance to us. Spending most of our time in buildings demands comfortable facilities and optimal building design, where users and visitors easily can adapt to surroundings, and the other way around. However, buildings age and become less energy-efficient through their lifetime, which means that they also have to be maintained and operated properly, in order to extend their lifetime expectancy and maintain property value. If not done so, buildings will slowly, but surely, become outdated and energy inefficient because of external influences and deterioration of building materials and components.

The need for renovation of buildings can also be related to problems with indoor climate. It has for a long time been generally recognised that bad indoor climate can lead to health problems. In 1983 the World Health Organisation defined at pathological picture termed Sick Building Syndrome or the indoor climate disease [6]. There is a large body of research dealing with indoor climate and health effects. Our initial needs and stakeholder analysis also revealed that problems with indoor

climate can be a reason for building renovation - not only in older buildings but also in fairly new buildings [7].

Building renovation is the process of fixing or replacing existing parts of the building to improve its performance, either to its original state or better [4]. At the same time, building renovations also provide the possibility to change building design/lay-out, functions, architectural expression etc. to match users' current and/or future needs. Combining multiple disciplines introduces complexity to building renovations, and because of that, interdisciplinary expertise is required to deal with most renovation projects.

Building renovations usually address several challenges in a specific property at the same time and therefore contribute with multiple benefits. Today, focus is mostly on energy-efficiency and deterioration, but there are also non-energy benefits of building renovations such as improvement of indoor climate, better daylight conditions, improved working spaces etc. In office buildings for instance, indoor climate is considered very important and can directly be linked to employee performance. Earlier research has shown that productivity can be increased 6 – 9 % by improving indoor air quality, which means that investments in indoor climate are also business investments [1]. Improving building design through renovations should therefore not only be a financial issue, but also the question of added value and better indoor climate conditions.

2.2 Barriers and incentives

Even though there are many benefits of building renovations, several international research studies have analysed the barriers for initiating renovation projects. The World Business Council for Sustainable Development (WBCSD) has produced a number of reports about energy efficiency in

buildings with a global outlook. In [8] they state that several barriers stand in the way of rapid progress ranging from market and policy failures, through professionals' inadequate knowledge and understanding, to the behaviour of building users. Their modelling work indicates that measures with a substantial impact are unlikely to meet normal financial investment requirements and are therefore unlikely to be implemented. Furthermore they identify several structural obstacles that significantly inhibit the likely take-up rate even of financially attractive investments.

A European ERABUILD project on building renovation and modernisation conclude in their final report [9] that the barriers in general are the lack of knowledge and information and the lack of cost effectiveness and funding. For owner-occupiers and private landlords the lack of knowledge and information, and funding, are seen as the main problems. An additional barrier for private investors is that they do not profit themselves from the investment made in rented out buildings – often called the landlord/tenant dilemma ([4]; [10]). In relation to opportunities, Itard et al. [9] regard that they are going to be generated by governmental actions and market processes. Demands of owners and occupants (e.g. with regard to comfort) have been changing and are going to change in the near future, which will have a positive effect on sustainable renovation.

In the UK, the Better Buildings Partnership has produced reports about low carbon retrofitting. The partnership identifies barriers in the following five areas [11]:

1. Commercial, including failure to provide a compelling and viable business case for investment in retrofit and the inherent split incentive between owners and occupiers.
2. Roles and Processes, including no defined process to designate individuals within an organisation with the responsibility and authority to identify, plan and deliver energy saving and carbon reduction interventions.

3. Financial, including access to and availability of capital funds – whether they are provided by the owner, occupier or third party.
4. Technology, including a lack of knowledge of the options available to upgrade buildings and issues associated with the implementation of specific retrofit activities.
5. Policy, including a lack of regulation or government intervention to stimulate the uptake of retrofit activity.

Internationally there is an increasing awareness of the importance of the behaviour of users in relation to improve energy efficiency ([12], [13], [14], [15], [16], [17], [18]). This does not only concern the time when the occupants use a building. A study from South Africa shows than in commercial buildings more energy is used during non-working hours than during working hours because lights and equipment including HVAC systems are left on at the end of the day; partly due to poor zoning and controls [19]. According to [20] there is minimal research concerning educational strategies for how to best educate building occupants. There is also an increasing focus on the important of the facilities managers for obtaining energy efficiency ([21], [22]).

The Danish Building Research Institute has identified a number of barriers for energy renovation divided in internal barriers, which cover the inertia among building owners, and external barriers covering lack of knowledge, resources and solutions [23]. One of the main incentives is supposed to be the Energy Labelling system (EMO). The regulation varies for different buildings types. However, recent research about the Energy Labelling in Europe concludes that the label is not being utilized by Danish building owners ([24]; [25]).

In Denmark there has recently been published a White Book on building renovation [26]. A stakeholder analysis has been made as a part of this work, and this summarizes the main barriers as follows [3]:

1. Too little political consciousness about the value creation by renovation
2. Weak economic incentive structures – including the landlord/tenant dilemma
3. Lack of life cycle cost perspective
4. Lack of standard solutions/concepts
5. Clear 'hen and egg' problem – lack of demand causing lack of development causing lack of demand
6. Overview and common direction is lacking among the actors
7. No overview of potential and priority
8. Renovation has an image problem compared to new building activities

The stakeholder analysis identifies a large number of different stakeholders with different interests in energy renovation of buildings, but except for the landlord/tenant dilemma, the stakeholders do not have contradictory interests.

2.3 Assessment methods and tools

One of oldest and most common methods for assessment of building performances is Post Occupancy Evaluation (POE), which was developed in the 1960's. As the name indicates, it is evaluation made after buildings are occupied and often consists of user surveys in combination with technical measurements of indoor climate etc. There are many publications on POE and one of the most frequently cited authors is the American researcher Wolfgang Preiser, for instance [27]. A study concerning POE has identified more than 150 different evaluation methods and made a

classification of the methods in relation to their main focus in four main groups – generic methods, beauty, usability and technology - with a visualisation and sub-divisions in a so-called Evaluation Focus Flower [28]. More recently methods have also been developed for pre-design evaluations [29].

However, the assessment methods and tools most related to this research have been developed with a focus on the building design process to support the decision-making process and/or to evaluate and possible make certifications of the building design. Many of these methods and tools have been developed with a focus on new building projects, but many can be used for building renovations as well, and some are specifically targeted or adapted towards renovation projects. Some of these are presented below.

Haapio and Viitaniemi [30] made a critical review of 16 different building environmental assessment tools with a focus on building design and/or finished buildings. Half of the tools can be used for existing buildings, but only 5 of those are suitable for assessment of refurbishments of a building. These include the internationally used environmental certification systems BREEAM developed by the British Research Establishment and LEED from the US Green Building Council as well as ATHENA^{TM} Environmental Impact Estimator from the ATHENA Sustainable Material Institute in Canada, BEAT 2000 from the Danish Building Research Institute in Denmark and EcoEffect from the Royal Institute of Technology (KTH), Sweden. BREEAM, EcoEffect and LEED are in the article classified as whole building assessment frameworks or systems, while ATHENA^{TM} and BEAT 2000 are classified as whole building design or decision support tools.

Gohardani and Bjørk ([31]; [32]) from the ACES project investigated selected tools and methods for refurbishment. They pointed to EPIQR as a decision support tool to upgrade current comfort standard, fulfil ecological demands and achieve optimal energy performance, which combines technical, financial, energy and comfort analysis for refurbishment. The flow of information from cost and energy performance characteristics enables the EPIQR-user to make informed decisions regarding building refurbishment. An interesting aspect of the EPIQR methodology is the involvement of tenants of the apartment buildings in form of questionnaires. This survey method gathers data on indoor environmental quality issues prior to any suggestions for suitable renovation actions ([33]; [34]: [35]; [36]; [37]). There are many multivariate designs and multiple criteria tools available for retrofit of buildings and ECBCS Retrofit Advisor represents one of these instruments that allow a simple evaluation of retrofit options for apartment buildings [38]. TOBUS is a decision-making tool for selecting office building upgrade solutions. With aims of elaborating consistent refurbishment scenarios and estimation of reasonable investment budget in the early stages of a refurbishment project, this method complements EPIQR. Different indoor environmental quality aspects of office buildings can also be investigated through TOBUS ([33]; [39]; [40]: [41]; [42]). XENIOS represents a proposed methodology for performance of a preliminary hotel audit and an initial assessment of cost-effective energy efficient renovation practices, technologies and systems ([43]; [44]).

A state of the art report on building renovation of buildings in Denmark was produced as part of the ACES project and it includes an overview of tools and methods [45]. The civil engineering department at the Technical University of Denmark has elaborated a number of methods. A report from 2008 includes a chapter about economical assessments [46]. It distinguishes between private and societal economical assessments. The latter is based on a guideline from the Danish Energy

Agency. For private economical assessments the report recommends the method Cost of Conserved Energy (CCE) or Cost of Saved Energy (CSE), which is a measure of the price of saving one kWh. The report from 2008 presents this method in a quite advanced form based on net present value calculations. In a more recent report from the same department with an idea catalogue for building renovation the method is used in a more simple form without including net present value calculations, finance cost, inflation and other future economic conditions [47].

Most of the methods and tools mentioned above have a narrow environmental or energy focus. The recent trend is towards development of more holistic tools for sustainability assessment and certification including also social and economic aspects. Examples of these are the international SBTool [48], the Australian CASBE [49] and the German DGNB [50]. The latter is particularly interesting in a European and Danish context, as it is based on all relevant European standards. The Danish Green Building Council has decided to adopt DGNB and has made an adaptation to national condition called DGNB-DK. The first version aimed at new office buildings, but since this research was finished the case project presented later in this article became a pilot project in developing a version of DGNB-DK adapted to existing housing estates [51].

3 METHODOLOGY

The research project has applied a qualitative multi-method research approach [52], including interview survey, case studies and a Delphi study. The interview survey was part of a needs and stakeholder analysis comprising of 10 semi-structured interviews with different types of stakeholders in relation to building renovation. The aim was, besides collecting general knowledge about renovation in practice, to identify the areas where further research and development could

make a difference and add value to the stakeholders involved in renovation projects. The analysis confirmed, as indicated by a former survey conducted by a consultant company [2], that there was a need for simple to use tools to support decision-making and evaluation of renovation projects. The detailed results of the analysis are presented in [7] and [53].

Based on that, the purpose of this research was to develop a simple, qualitative assessment tool aimed at guiding the setting of objectives and supporting dialogue among user representatives and professional stakeholders in the early stage of renovation project. A requirement specification and an outline of the tool were developed based on the literature review and the interview survey. The results formed the basis for the first round of the Delphi study [54] with an expert panel of 18 participants representing different types of stakeholders taking place in March 2012. The purpose of this round was to test the quality and relevance of the requirement specification and tool outline.

The further development included 4 case studies of renovation projects in different stages. These included a large multi-storey housing project in the early design and decision phase, a municipal school project in the middle of renovation, an office project near the end of renovation and a finished pilot project on one residential building as part of a large multi-storey housing estate. The case studies included interviews with the main stakeholders, documents studies, site visits, and in the case presented later in this article, also participation in tenant information and decision meetings. The RENO-EVALUE tool was tested for validation on all the four case studies by some of the stakeholders among the interviewees. The evaluations were collected by use of standardised information and interview templates, which were prepared for each case study. Each interviewee was presented with the same basic information about the case project, see example in Table 1. The interviewees were asked to give their evaluation as a score on a five point Likert scale for each of

the 8 parameters included in Figure 2 and Table 1. Together with each score they were also asked to give their main reason for their score.

The results from testing the RENO-EVALUE tool on the case studies were further tested and validated at a second round of the Delphi study with 23 participants in April 2013. The purpose of this round was to make a critical evaluation of the tool based on the test results from the case studies, before making the final version of the tool. It was not possible during the research project to test the tool on a renovation project in a very early phase (pre-project), but we did develop a special template aimed at defining objectives for a new renovation project. However, as this has not been tested yet, it will not be presented in this article.

The detailed results of the research are presented in the Danish main report of the ACES project [55]. This article will briefly present RENO-EVALUE and one of the case studies as an example of using the tool.

4 FINDINGS

4.1 RENO-EVALUE

RENO-EVALUE is a tool for holistic assessment of sustainability in building renovation projects. The main purpose of RENO-EVALUE is to be used as a decision support tool in the early stages of renovation projects. It is a process-oriented tool that can be used by anyone with insight into the project. RENO-EVALUE is not only focusing on a final product, but covers project organisation, economy and renovation process, too. It can be used to formulate objectives for renovation projects and to enable focus on essential aspects for the primary decision makers. It can also be used as a communication tool between different stakeholders and help in making evaluations on the basis of

expectations. The tool is able to monitor and evaluate the obtained results and provides the opportunity to compare different projects and evaluate alternative proposals. RENO-EVALUE is also planned to be used to illustrate cases in the form of inspirational projects.

4.1.1 Target group

RENO-EVALUE can be used by the decision-makers who not necessarily possess the adequate technical competences for evaluating the energy renovation projects. The tool can be used by all stakeholders involved in the early stages of building renovation project, as long as they have some knowledge about the project.

The evaluation tool is intended for use on large scale projects in the professional sector, not single family houses etc. Primary users of RENO-EVALUE might be client organisations, housing associations, estate administrators, project managers, design managers and facilities managers. One of the advantages of RENO-EVALUE is that it can be used as a communication tool between developers/landlords/consultants/designers and representatives of inhabitants, tenants, employees and building users. It can also be used by project managers to manage the expectations of the different stakeholder and to show to which degree the objectives have been met. Architects, consultants and contractors might use RENO-EVALUE for illustrations, assessments, and comparisons of different proposals.

4.1.2 Application method

Since the tool is addressing different stakeholder groups, it has to be easy to understand and simple to use. Data is collected through interviews with primary stakeholders and there are no new technical calculations in the tool. An interviewer collects facts about the project beforehand and

validates them with the stakeholders during the interviews. Interview questions are standardized with minor deviations depending on stakeholders and building types. The evaluation of a project is based on subjective assessments, but supported by project facts. Furthermore, there should be an explanation for each rating, and the information about the valuator should also be available.

The RENO-EVALUE model can be illustrated as a spider's web as shown for the case study in Figure 2. It is possible to rate parameters and their factors with grades 1-5 from low to high. The rating can be made both before and after the energy renovation is completed, which in the end makes it possible to compare the expectations with the final results. The advantages of RENO-EVALUE are that it does not take long time to do the evaluation, the graphical illustration of results is easy to understand, and the model provides a quick overview of the current situation, seen from a certain stakeholder's perspective. It can for instance be useful in the early stages of the energy renovation projects, in order to improve the matching of expectations between different stakeholders and defining the success criteria for a project. After the project is completed, the evaluation results from the initial phase can be used to determine whether the success criteria are fulfilled or not, and there is also possibility to evaluate the project again. The evaluations can internally be used to compare "before and after" situation, and externally for experience exchange and comparison between different projects.

4.1.3 Parameters in the tool

The evaluation tool RENO-EVALUE covers the four main categories: Stakeholders, Environment, Project organisation, and Economy. Each category is divided in two parameters with a sub-division in a number of factors. The categories and the parameters are generic in relation to building types, while some of the factors are dependent on the specific building types. Factors are shown for each

category and parameter for the case study in Table 1. This is based on renovation of housing estates, which has specific factors for this building type concerning the ”Value” parameter.

4.2 Case study

The social housing estate Sorgenfrivang II consists of 3 high-rise buildings of 15 storeys placed near Sorgenfri Station in the suburb Virum, 20 km north of Copenhagen city. The estate has 428 flats covering 9 different types (1-6 rooms), and it is a department in a housing association. The estate was occupied during 1957-59 and the total floor area is 45.000 m^2. An aerial view of the estate is shown in Figure 1.

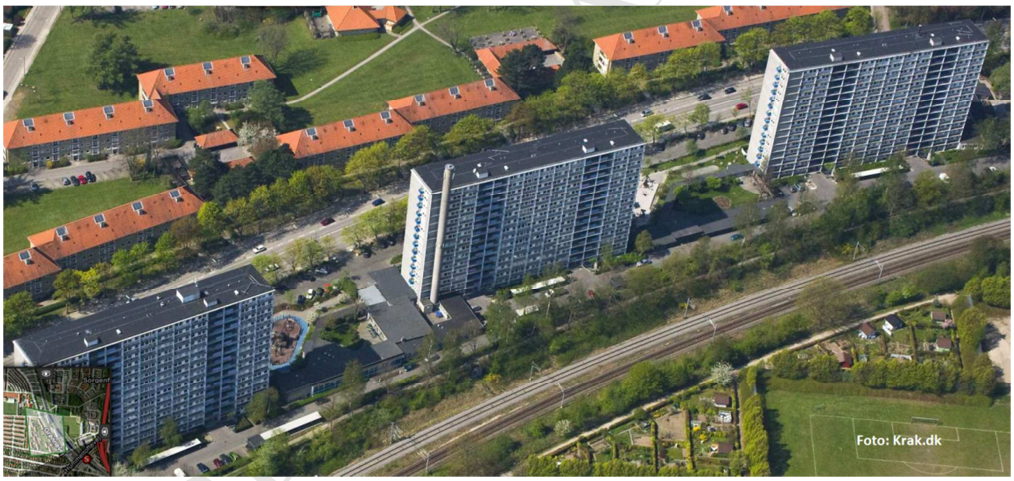

Figure 1: Aerial view of Sorgenfrivang II

The local municipality has classified the estate as worth preserving, which means the architectural appearance of the high-rise blocks cannot be changed radically. Over the years, a major maintenance backlog has been established and there is an urgent need for a major renovation of the estate. The buildings have many technical challenges like poor insulation and leaky facades,

problems with mould fungus, cold bridges etc. as well as visible concrete damages. Besides these challenges, there is also a need for functional improvements. The lifts are worn down and only stop at every second floor. The plumbing is old and out-dated, and the balconies are very small. Besides being of annoyance for the tenants, these disadvantages also has a negative effect on the energy consumption.

The planning of the renovation project started in 2008 and the process has been long and troublesome, including a change of consultants and major alterations of the project. As part of the preparation of the renovation a master plan has been produced. In 2012, the national Danish Building Foundation (Landsbyggefonden) offered to support the project based on the master plan. In October 2012, a great majority of the tenants accepted the project, including a major rent increase when the project is finished.

The total cost of the project is 511 million DKK (68 million Euro). The rent will increase from 688 DKK/m^2/year in 2012 to 953 DKK/m^2/year (from 92 to 127 Euro/m^2/year) after the renovation - equivalent to 38.5 %. However, the increased rent is at the same level as similar housing estates in the area. The energy consumption is expected to be reduced by up to 66% from 89.9 to 30.6 kWh/m^2/year. After the decision was taken in October 2012, the detailed design of the project started. The renovation project is planned to be finished by the end of 2016.

4.2.1 RENO-EVALUE description and evaluations

The case study is based on interviews with the main stakeholders during 2012 before the decision and evaluations by the same stakeholders after the decision in late 2012 and early 2013. A standardised description of the renovation based on the parameters and factors in the RENO-

EVALUE tool was prepared by the ACES researchers and is shown in Table 1. The stakeholders' evaluation of each of the 8 parameters is shown in Figure 2.

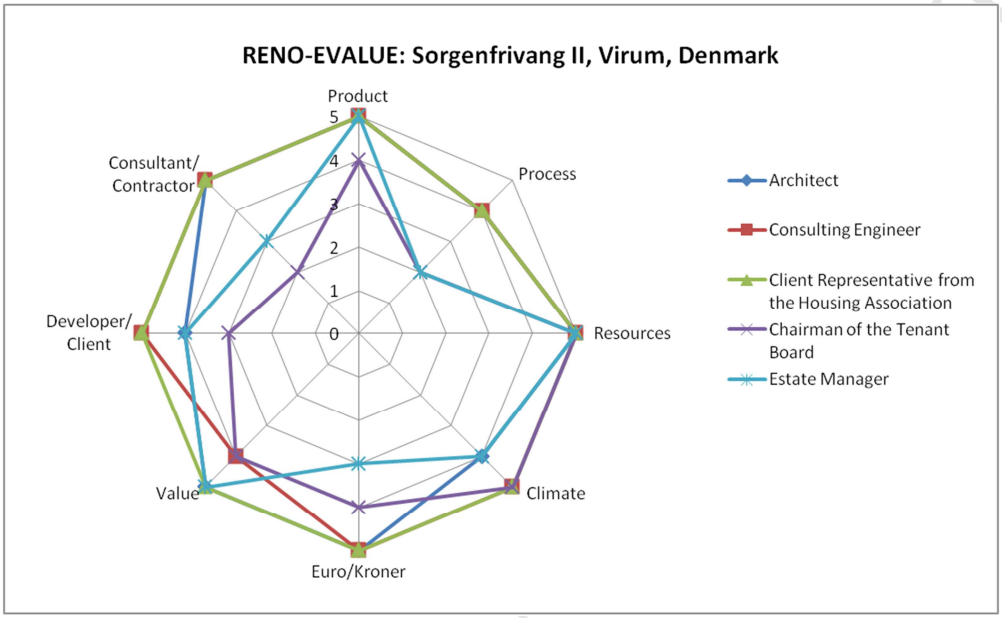

Figure 2: RENO-EVALUE evaluations of Sorgenfrivang II

Figure 2 shows that the 5 actors agree on some parameters and disagree on others. All of the actors agree that the renovation will make the estate much more environmentally friendly with regards to resources (grade 5), and the expected energy saving of 66% is referred to as the most important argument.

The viewpoints concerning the process are quite differentiated. While the architect, the consulting engineer and the client representative from the housing association characterise the process as "better than could be expected" (grade 4), the chairman of the tenant board and the estate manager

characterise the process as “worse than could be expected” (grade 2). The arguments given by the first group include expressions like ”*Engaged tenants, client and consultants*” and ”*Excellent collaboration*”, while the second group experience the situation very differently with expressions like ”*The start phase went well, but in the final phase the situation has changed*” and that ”*There has not been a wish to involve the tenants*”.

Table 1: RENO-EVALUE description of Sorgenfrivang II

Category	Parameter	Factors	Preconditions
Stakeholders	Product	Architecture and aesthetics	• *Important to keep the architectural expression*
		Function and usability	• *Larger balconies (50 %) and lifts* • *New kitchens and bathrooms* • *Glass covering of stairwells.*
		Indoor climate and comfort	• *Less draught/cold bridges* • *Improved temperature regulation* • *More daylight/improved outlook* • *Mechanical ventilation*
		Durability/future securing	• *New facades and installations with long lifetime (min. 30 years)* • *Comply with current energy requirements*
	Process	Collaboration between partners	• *Based on traditional principles*
		Mutual information	• *Follows traditional principles*
		Involvement of users	• *Workshops in 3 groups on different topics* • *Tenants meeting with voting*
		Considerations for users during	• *Tenants can stay during renovation*

		construction	
Environment	Resources	Energy consumption	• *Expected reduction from 89.9 kWh/m^2/year to 30.6 kWh/m^2/year – up to 66 % in average* • *Energy label improvement from D to A.* • *Greatest effect by replacing windows (38 %) and glass covering of stairwells (22 %)*
		Renewable energy production	• *900 m^2 photo voltaic cells on roofs* • *Expected effect: 135.000 kWh/year*
		Water consumption	• *Rain water collection on low buildings*
		Reuse of water	• *Rain water for laundry*
		Reuse of building materials	• *Not known*
		Amount of waste	• *No changes – waste suction system was installed in 2002.*
		Reuse of waste	• *No changes*
	Climate	CO2 emission	• *CO2 reduction not estimated.* • *CO2 neutral laundry.* • *Renewable energy production (photo voltaic cells on roof))* • *Reuse of rain water* • *Energy saving lighting in common areas*
		Pollution	• *Not estimated – indirect effects of the above mentioned measures*
		Local discharge of water	• *Not known*
Economy	Euro/ Kroner	Reasonable rent	• *Considerable rent increase of 38.5 %, but from a low present level.*
		Reasonable running cost	• *Considerable reduction in heating cost* • *Reduced expenses of external maintenance in a number of years.*

		Reasonable cost in the long term	• *Depends on financing and price development (inflation + energy prices)* • *Probably not major other rent increases for a long period (assumption)*
	Value	Desirable dwelling	• *Modern buildings – updated to present standard.* • *Green image from environmental measures (photo voltaic cells on roofs)* • *New kitchens and bathrooms*
		Well-functioning estate	• *Improved access areas and lifts*
		Attractive area	• *Architectural upgrading*
Project Organisation	Developer/ Client	Project management skills	• *Large, professional housing association as client representative*
		Ability for decisions	• *Very engaged tenant board* • *Great political attention locally*
		Technical competence	• *Based on external consultants*
		Cooperative skills	• *On-going collaboration based on a frame agreement with the main consultant*
		Involvement of the operating organisation	• *Represented in the building committee.*
		Risk/responsibility/innovation	• *Large building committee.*
	Consultant/ contractor	Project management skills	• *Main consultant selected based on a frame agreement.*
		Technical competence	• *The current consultant has been selected to replace a former consultant* • *Both architect and consulting engineer have extensive experiences with large housing renovation projects* • *Both consulting engineer and architect apply energy simulation tools.*

			• *Both architect and consulting engineer apply a sustainability triangle tool*
		Problem solving ability	• *Not known.*
		Cooperative skills	• *Consulting engineer and architect company have collaborated on earlier projects* • *Both consulting engineer and architect are represented by a partner in the project organisation.*
		Coherence in supply chain	• *The consulting engineer company is main consultant with the architect company as sub-consultant* • *The architect has been selected in agreement between the client representative and the main consultant*
		Risk/responsibility/innovation	• *The project is now in the design phase* • *The contractor has not been selected yet.* • *Long construction period (3 years) – possibility for improvements and innovations along the way.*

The evaluations of consultant/contractor are also quite differentiated between the same two groups. The architect, the consulting engineer and the client representative assess the organisation on the consultant part to be “very suitable” (grade 5), while the chairman of the tenant board and the estate manager assess the consultant part as ”acceptable” (grade 3) and “unsuitable” (grade 2), respectively. The arguments for the high grades are ”*Very engaged, curious and professional team*” og ”*Exceptionally engaged and professionally competent*”, while the lower grades are explained by

”*They (the consultant team) are excluding and do not always hear what we want and wish*” and ”*They should learn to practice tenant involvement*”.

5 DISCUSSION

RENO-EVALUE is intended for holistic assessment of sustainability in building renovation projects. The main purpose of RENO-EVALUE is to be used as a decision support tool in the early stages of renovation projects. Applying RENO-EVALUE in practice through case studies has revealed its strengths and weaknesses.

When working with existing buildings, but also constructing new ones, first thing that needs to be considered is who do we design these buildings for? How can we create buildings that are also going to be livable after 20 year? Is it realistic at all? It is important to keep in mind who are the end-users, and what their present and future needs are/might be. It is also very relevant to know the relationship between building owners and building users. Applying RENO-EVALUE on concrete renovation projects in Denmark has revealed some interesting things for building renovation projects. Our research has shown that end-users are usually most unsatisfied stakeholders - not on the end product, but on the renovation process. End users often consider themselves unseen or unheard in early phases of a renovation project, before final decisions are made.

Other dilemmas that have been raised through the case studies and use of RENO-EVALUE tool concern the added value of energy renovations and whether focus should only be on energy savings, or should non-energy benefits be just as important? How important is indoor climate to us, if we know that we spend most of our time indoor? Should improvements in indoor conditions be

considered as equally, or even more important than return of investment and expected energy savings? As described earlier, indoor climate conditions have an impact on our health and productivity, which means that these parameters should also be taken into account when considering building renovations or investments in building improvements.

RENO-EVALUE is based on collecting the subjective views of stakeholders and in that way it is similar to many methods for Post Occupancy Evaluations. However, RENO-EVALUE does not only include the views of the occupants, but of all main stakeholders in a renovation project. Unlike most POEs, RENO-EVALUE does not only collect satisfaction scores, but also ask the involved stakeholders to give their arguments behind their ratings. In this way it can, unlike POEs, be used as a tool to support decision-making, dialogue and expectation management among professionals and building users – not only after occupation but both in the early stages of and during renovation projects.

RENO-EVALUE is a holistic sustainability tool that similar to most recent sustainability assessment systems takes all aspects of sustainability into account, but it has it strengths compared to such systems by being very simple to use and can create easy understandable overviews taking the different views of the main stakeholders into account. Unlike other decision support tools, RENO-EVALUE does not require new technical calculation and involvement of technical experts. Therefore, it is a simple and inexpensive tool to use.

RENO-EVALUE makes it possible to compare the added value of a renovation project with its economy and end-product, but the other side of the coin is that the tool does not make deeper

analysis of a relation between these parameters. Case studies have revealed that RENO-EVALUE is easy to use by project stakeholders and that it provides a quick overview at a current situation from different points of view. At the same time, its simplicity may in some cases also be considered as its greatest weakness since the tool does not present new technical calculations or includes as many parameters as more comprehensive tools like LEED, BREEAM, CASBE, SBTool and DGNB do. While these assessment and certification tools mainly focus on buildings or urban environments and their performance, RENO-EVALUE covers some new aspects of renovation projects that are not necessarily covered by these leading assessment tools. RENO-EVALUE is for instance assessing project organization, project management and value creation throughout entire project and reveals different stakeholders' subjective opinions on project quality. In this sense RENO-EVALUE is not just one more technical tool, but a unique process-oriented evaluation tool that illustrates the value of both qualitative and quantitative parameters of a building renovation project from different perspectives.

The experiences from all four case studies showed that it is possible and unproblematic to get access to all the main stakeholders in the projects concerning social housing projects and public facilities. However, in the case concerning a privately owned rented out office facility we were not allowed access neither to the owner (a pension fund) nor the tenant and users (state agencies). We only – with the owner's permission - had access to the real estate administration company and the consulting engineer. This might reflect a general problem with getting access to all the main stakeholders in privately owned rented out facilities.

6 CONCLUSION

Earlier research has documented many barriers for initiation of sustainable refurbishment and energy renovations. Research on the barriers for building renovation in Denmark has revealed that an important obstacle is a lack of simple and holistic tools that can assist stakeholders in decision-making during the early stages of projects.

There are a number of tools developed to support energy simulation and building design, but there is a lack of simple tools that can support the initial goal setting among the primary stakeholders in early project stages and support the dialogue between non-professional user representatives and building professionals in housing associations, architect and engineering consultants companies and contractors. This is where the new tool RENO EVALUE is targeted and it is planned as a holistic and qualitative tool to define objectives and clarify expectations as part of an initial dialogue and decision making process and as possible tool to follow-up on decisions and evaluate results. It is a value based and process oriented tool, which focuses on the different views and interest of the involved stakeholders. It can be used by project managers to manage objectives and expectations and by design managers to guide design activities and evaluate design solutions. Unlike other decision support tools, RENO-EVALUE does not require new technical calculation and is an easy and inexpensive tool to use.

RENO-EVALUE is based on the three general accepted pillars of sustainability: Environment, Social and Economy, but being a tool related to renovation of buildings, it also includes evaluation of the organisation involved in implementing such projects seen both from the demand and the supply side to achieve an even more holistic assessment. Environmental sustainability is addressed through the “Environment” category including both resource consumption and climate impacts. Social sustainability is addressed by the “Stakeholder” category including both product and process

aspects. Economy is addressed both as quantitative short and long term costs and in qualitative value aspects.

In the case study of Sorgenfrivang II better accessibility, bigger balconies and new kitchens and bathrooms were part of a renovation project, together with energy efficiency improvements. This is adding value to the property as well as being part of a sustainable building renovation, because sustainability is not just about energy-savings and environmental issues – it is also a question of social responsibility and quality of life for the building users. However, the case study also showed that a limited involvement in the renovation process caused dissatisfaction among the users. This is an often overlooked aspect, which the value based tool is capable to reveal.

It is an important limitation of this research, that RENO-EVALUE has not been tested in the pre-project phase of a building renovation, and this is an obvious aim for further research and development. The tool has during the Eracobuild project been discussed with our partners from Sweden and Cyprus, but it was not possible during the project to test the tool on cases outside Denmark. Thus, testing the tool in other countries is another obvious perspective for further development. As pointed out by one of our reviewers, linking the tool to a Building Information Model is also an interesting possibility for future development.

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VALUE BASED BUILDING RENOVATION –

A TOOL FOR DECISION-MAKING AND EVALUATION

HIGHLIGHTS

- A tool - RENO-EVALUE - for decision support of sustainable renovation is presented
- It is a simple and holistic tool to assist in prioritisation during early stages
- It is value based by focusing on the priorities of different stakeholders
- The tool can be used for evaluation during and after building renovation projects
- A case study of renovation of a housing estate used to test the tool is presented